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Evolution of chemical weathering processes and CO_2 sequestration in the glaciated basins of Western Himalayas

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Understanding of chemical weathering process involved in ionic elution helps in distinguishing the CO_2 sequestration rate at the different micro-climatic setup of Himalayan catchments. In the present study, we have selected three glaciated basins from two different climatic zones of Western Himalayas (Lato and Phutse from the cold-arid zone of Ladakh and Chhota Shigri from the monsoon-arid zone of Himachal Pradesh, India) for determining various solute sources, CO_2 sequestration rate and its control over melt-water quality. Solute sourcing models used in this work shows major cations like Ca^{2+} and Mg^{2+} are from crustal rock-weathering while Na^+ and K^+ sourced out from the sea-salt origin. However, major anions like SO_4^{2-} (> 85%) were derived from the crustal origin and HCO_3^- mostly derived from atmospheric sources (39% to 45 %) in all catchments except HCO_3^- contribution from carbonation dissolution and silicate weathering is ~29% and ~16% for Ladakh catchments compared to ~9 % and ~29% in Chhota Shigri respectively. The solute model also reveals that the contribution of sulphate oxidative mediated carbonate dissolution (SOCD) in HCO_3^- flux is relatively higher in Chhota Shigri (~16%) than others (~9%). It is also observed that catchment like Chhota Shigri having a combined network of channelized and distributed drainage patterns with lower specific discharge, more glacierized area, low pH, high pCO_2, Low molar ratio $[Ca^{2+} + Mg^{2+}]/[Na^+ + K^+]$, high SMF (~ 0.4), low $CO_{2\ carbonate}/CO_{2\ silicate}$ ratio (~1.3) show relatively more sulphide oxidative and silicate weathered products than other catchments. Conversely, presence of excess non-glaciated areas in Stok and Phutse having well-channelized subsurface discharge with high $CO_{2\ carbonate}/CO_{2\ silicate}$ ratio (~10 to ~5) show enhanced carbonation via atmospheric CO_2 (CAC) and carbonate dissolution with high annual CO_2 sequestration. Thus, varying subglacial drainage system, specific discharge pattern and reactive rock-types with distinct hydro-micro-climatic set up alters the chemical weathering mechanism in these catchments and control meltwater quality.